



New Hampshire Department of Safety Division of Fire Standards & Training And Emergency Medical Services

Recommended Curriculum for

Advanced Spinal Assessment

The Role of the NH

EMT – Basic
EMT- Intermediate
EMT - Paramedic

July 2005

OBJECTIVE

Objectives Legend

C = Cognitive	1 = Knowledge level
P = Psychomotor	2 = Application level
A = Affective	3 = Problem-Solving level

COGNITIVE OBJECTIVES

At the completion of this unit, the EMT student will be able to:

1. Discuss the history of prehospital spinal immobilization and new protocol development.
2. Describe the anatomy and physiology of structures related to spinal injuries.(C-1)
 - a. Cervical
 - b. Thoracic
 - c. Lumbar
 - d. Sacrum
 - e. Coccyx
 - f. Head
 - g. Brain
 - h. Spinal cord
 - i. Nerve tract(s)
 - j. Dermatomes
4. Describe the pathophysiology of spine injuries. (C-1)
5. Relate mechanism of injury to potential traumatic spinal injuries. (C-1)
6. Describe the assessment findings associated with traumatic spinal injuries. (C-1)
7. Describe the management options and associated risks and benefits for possible traumatic spinal injuries. (C-1)
 - a. Full immobilization
 - b. Advanced Spinal Assessment per NH Patient Care Protocol
8. Develop a patient management plan for possible traumatic spinal injury based on the assessment findings. (C-3)

AFFECTIVE OBJECTIVES

At the completion of this unit, the EMT student will be able to:

1. Advocate the use of a thorough assessment when determining the proper management option for potential traumatic spine injuries. (A-3)
2. Value the risks and benefits of each management option for potential spinal injuries. (A-3)

PSYCHOMOTOR OBJECTIVES

At the completion of this unit, the EMT student will be able to:

1. Demonstrate a clinical assessment to determine the proper management option of a patient with a suspected traumatic spinal injury. (P-1, 2, 3)
2. Demonstrate the application of the Advanced Spinal Assessment per NH Patient Care Protocol. (P- 1, 2)

PREPARATION

Motivation:	EMS providers play an important role in the delivery of emergency care and are expected to provide care that is consistent with that provided within an Emergency Department (ED). Full immobilization of a patient is not a benign procedure and can cause increased pain or further complicate patient treatment when it's not necessary. The NH Patient Care Protocol for Advanced Spinal Assessment attempts to align prehospital practice with ED care in NH and further address patients' needs and comfort.
Prerequisites:	NH Licensed at the level of EMT-Basic or higher.

MATERIALS

AV Equipment:	Utilize various audio-visual materials relating to injuries of the head and spine. The continuous design and development of new audio-visual materials relating to EMS requires careful review to determine which best meet the needs of the program. Materials should be edited to assure meeting the objectives of the curriculum.
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PERSONNEL

Primary Instructor:	One educator knowledgeable in, EMS, spinal emergencies and their treatment and the NH Patient Care Protocol Advanced Spinal Assessment.
Assistant Instructor:	The instructor-to-student ratio should be 1:6 for psychomotor skill practice. Individuals used as assistant instructors should be knowledgeable in spinal emergencies, treatment and the NH Patient Protocol Advanced Spinal Assessment.
Recommended Minimum Time to Complete:	Four hours

PRESENTATION

DECLARATIVE

- I. Historical perspective of prehospital management of suspected spinal cord injuries:
 - A. Spinal cord injury (SCI) impacts
 - 1. Human physiology
 - 2. Lifestyle
 - 3. Financial
 - 4. \$1.25 million to care for a single victim with permanent SCI (overall life span)
 - B. Secondary to potential impact of a SCI, prehospital management of suspected spinal cord injuries has emphasized full immobilization based on any MOI with a potential for a SCI.
- II. Progression of prehospital spinal assessment and management:
 - A. Effort to align prehospital care with ED care.
 - B. Studies (i.e. NEXUS 2000) and recommendations (i.e. 2000 Update - EAST Cervical Spine Clearance Document) showing that a stepped clinical decision rule for suspected SCI is effective in the prehospital setting.
 - C. Potential complications of full immobilization:
 - 1. Increased pain and discomfort
 - 2. Psychological affects
 - 3. Nausea/vomiting
 - 4. Complicate treatment of patient when not necessary
- III. General spinal anatomy and physiology review
 - A. Spinal column
 - 1. Long bone
 - 2. 33 vertebrae
 - 3. Head balances at top of spine
 - 4. Spine supported by pelvis
 - 5. Ligaments and muscles connect head to pelvis
 - 6. Injury to ligaments may cause excess movement of vertebrae
 - B. Cervical spine
 - 1. 7 vertebrae
 - 2. Supports head (15 - 22 lbs.)
 - 3. Considered "joint above" in splinting
 - 4. Very flexible
 - 5. C1 (atlas)
 - 6. C2 (axis)
 - C. Thoracic spine
 - 1. 12 vertebrae
 - 2. Ribs connected
 - 3. Provides rigid framework of thorax

- D. Lumbar spine
 - 1. 5 vertebrae
 - 2. Largest vertebral bodies
 - 3. Flexible
 - 4. Carries most of body weight
 - 5. Torso balances on sacrum
- E. Sacrum
 - 1. 5 fused vertebrae
 - 2. Common to spine and pelvis
 - 3. Forms “joint below” with pelvis for splinting
- F. Coccyx
 - 1. 4 fused vertebrae
 - 2. Tailbone
- G. Vertebral structure
 - 1. Body
 - a. Constructed of cancellous bone
 - b. Posterior portion forms part of the vertebral foramen
 - c. Increase in size when moving from cervical to sacral region for support of the trunk
- H. Vertebral foramen
 - 1. When all vertebrae are in place forms opening for spinal cord (vertebral canal)
- I. Transverse process
 - 1. Projects laterally and posteriorly
 - 2. Attachment site for various muscles and ligaments
- J. Spinous process
 - 1. Posterior aspect
 - 2. Attachment site for muscles and ligaments
- L. Intervertebral disk
 - 1. Mass of fibrocartilage separating each vertebrae
 - 2. Connecting together by ligaments
 - 3. Acts as a shock absorber
 - a. Reducing bone wear
 - b. Compression protection
- M. Brain and spinal cord (central nervous system)
 - 1. Brain
 - a. Largest and most complex portion of the nervous system
 - b. Continuous with spinal cord
 - c. Responsible for all sensory and motor functions
 - 2. Spinal cord
 - a. Located within the vertebral canal
 - (1) Begins at foramen magnum
 - (2) Ending near L-2 (cauda equina)
 - b. Dural sheath
 - (1) Sheathed, tube-like sac
 - (2) Filled with cerebrospinal fluid (CSF)

3. Ascending nerve tracts
 - a. Carries impulses from body parts and sensory information to the brain
 - b. Conduct sensory impulse from skin, muscle tendons, and joints to the brain for interpretation as sensations of touch, pressure, pain, temperature and body movement
 - c. Cross over at the medulla oblongata from one side to the other, therefore impulses originating from the left side ascend to the right side of the brain and vice versa
4. Descending nerve tracts
 - a. Carries motor impulses from the brain to the body. Motor impulses originate in the brain to control muscle tone, sweat gland, muscle coordination and control of posture.
5. Spinal nerves
 - a. 31 pairs
 - (1) Originates from the spinal cord
 - b. Mixed nerves
 - (1) Carries both sensation and motor function
 - (2) Provides two-way communication between spinal cord and body parts
 - c. Named according to level of spine from which they arise
 - (1) Cervical 1-8
 - (2) Thoracic 1-12
 - (3) Lumbar 1-5
 - (4) Sacral 1-5
 - (5) Coccygeal 1 set of nerves
 - d. Spinal nerve
 - (1) Emerges from the cord
 - (2) Two short branches or roots (Dorsal Root - sensory impulse from the cord. Ventral Root - motor impulses from the cord to the body)
6. Motor and sensory dermatomes
 - a. Dermatomes are topical regions of the body innervated by a specific spinal nerve
 - b. Mapped out by level of the spinal nerve
 - c. Useful for assessment for a specific level of SCI
 - d. Examples of common nerve root and motor/ sensory correlation:

<u>Nerve Root</u>	<u>Motor</u>	<u>Sensory</u>
C-3, 4	Trapezius (shoulder shrug)	Top of shoulder
C-3, 4,5	Diaphragm	Top of shoulder
C-5, 6	Biceps (elbow flexion)	Thumb
C-7	Triceps (elbow extension) wrist/ finger extension	Middle finger
C-8/ T-1	Finger abduction/adduction	Little finger
T-4	Nipple	
T-10	Umbilicus	
L-1, 2	Hip flexion	Inguinal crease
L-3, 4	Quadriceps Medial thigh/ calf	
L-5	Great toe/ foot dorsiflexion	Lateral calf

S-1	Knee flexion	Lateral foot
S-1, 2	Foot plantar flexion	
S-2, 3,4	Anal sphincter tone	Perianal

IV. Pathophysiology of Spinal Injuries:

A. Mechanisms and Associated Injuries

1. Hyperextension
 - a. Most commonly in the cervical and/or lumbar area
 - b. Potential disk disruption, compression of ligaments, fractures
 - c. Torn ligament and/or fractures may lead to instability
2. Hyperflexion
 - a. Most commonly in the cervical and/or lumbar area
 - b. Potential anterior vertebral body wedge fractures, stretch/torn ligaments, cord compression, disk disruption with potential vertebrae dislocation
3. Rotational
 - a. Most commonly in the cervical area but possibly in lumbar region as well
 - b. Potential stretching/tearing of ligaments, rotational subluxation or dislocation, fractures
4. Compression
 - a. Most commonly between T12 and L2
 - b. Potential compression fractures, herniated/ruptured disk
5. Distraction
 - a. Most commonly in upper c-spine
 - b. Stretching/pulling of the cord
 - c. Potential damage to cord without damage to spinal column, potential torn ligaments
6. Penetrating
 - a. Forces directed to spinal column
 - b. Potential fractures, damage to cord, disruption of ligaments

B. Specific Injuries

1. Fracture
 - a. Cause potential instability
 - b. Loose bone fragments
 - c. Disruption of cord
2. Ligament, Tendons and/or Muscles
 - a. Potentially stretched, compressed or torn/disrupted
 - b. Potential instability of spinal column
3. Dislocations / Subluxation
 - a. Displacement of Vertebrae potential disrupting the cord
 - b. Potential instability to spinal column
4. Disk Herniation / Rupture
 - a. Displacement or rupture of disk
 - b. Potential disruption of cord

- 5. Cord Injuries
 - a. Concussion
 - (1) Temporary or transient disruption of cord function
 - (2) Similar to cerebral concussion
 - (3) Generally does not produce residual deficits
 - b. Contusion
 - (1) Bruising of the cord with associated tissue damage, swelling, vascular leakage.
 - (2) Blood crossing blood-brain barrier may increase swelling significantly.
 - (3) Likely to recover from with limit or no deficit.
 - c. Compression
 - (1) Pressure on cord secondary to swelling, vertebrae displacement, disk herniation, etc.
 - (2) Causes potential restricted circulation, ischemia or physical damage to cord
 - d. Laceration
 - (1) Direct damage to cord
 - (2) Likely to involve hemorrhage into cord tissue, associated swelling, and possible disruption of cord
 - (3) Potential disruption of cord "communication" pathways
 - (4) Minor laceration may have some recovery. Severe laceration usually result in permanent damage.
 - e. Hemorrhage
 - (1) Often associate with other injury such as laceration, contusion, stretching, etc.
 - (2) Causes potential disruption of blood flow, pressure to cord, and/or irritation secondary to blood crossing blood-brain barrier
 - (3) Potential ischemic injuries secondary to decreased blood flow
 - f. Transection
 - (1) Partial or complete disruption of cord
 - (2) Causes partial or complete loss of sensory and motor function below injury site
- 6. Spinal Shock
 - a. Temporary insult to cord that affect the body below the level of the injury
 - b. Affected areas are flaccid, loss of sensation, loss of motor control
 - c. Potential priapism, loss of bowel/bladder control, loss of temperature regulation
 - d. Potential hypotension
 - e. Generally transient problem if no significant injury to cord
- 7. Neurogenic Shock
 - a. Injury to cord that affects the brain's ability to control body
 - b. Disruption can affect vasoconstriction below level of injury
 - c. Decreased sympathetic tone causes expansion of arteries and veins creating a relative hypovolemia
 - d. Decreased cardiac output secondary to decreased preload

- e. Decreased epinephrine release resulting in decreased heart rate, decreased blood pressure and decreased vasoconstriction

V. Signs and symptoms which may indicate SCI:

- A. Pain
- B. Tenderness
- C. Painful movement
- D. Deformity
- E. Cuts/ bruises (over spinal area)
- F. Paralysis
- G. Paresthesias
- H. Paresis (weakness)
- I. Shock
- J. Priapism

VI. General assessment and Management of spinal injuries:

- A. Perform scene size up and initial assessment
- B. Perform focused history and physical exam - Determine mechanism of injury/ nature or injury
 - 1. Positive MOI - Forces or impact involved suggest a potential SCI
 - a. Examples:
 - (1) High speed motor vehicle crash(es)
 - (2) Falls greater than three times patient's height
 - (3) Axial Loading
 - (4) Violent situations occurring near the spine
 - (5) Stabbings
 - (6) Gun shots
 - (7) Sports injuries
 - (8) Other high impact situations
 - (9) Consideration to special patient population (e.g. pediatrics, geriatrics, history of Down's, etc.)
 - 2. Negative MOI - Forces or impact involved does not suggest a potential spinal injury
 - a. Examples
 - (1) Dropping a rock on foot
 - (2) Twisted ankle while running
 - (3) Isolated soft tissue injury
 - 3. Uncertain MOI - Unclear or uncertainty regarding the impact or forces
 - a. Examples
 - (1) Person trips over garden hose, falling to the ground and hitting their head
 - (2) Fall from 2-4 feet
 - (3) Low speed motor vehicle crash (fender bender)
 - 4. When using the Advanced Spinal Assessment, positive mechanism of injury is not considered means to necessitate full immobilization of a patient, but should be used as a historical component that may heighten a provider's suspicion for a spine injury.

C. Advanced Spinal Assessment

1. Define NH Patient Care Protocols
 - a. Issued by the NH Medical Control Board (MCB) and NH Bureau of EMS
 - b. Role of Medical Resource Hospital (MRH) standing orders/off-line versus on-line
 - c. Scope of education v. scope of practice
2. Performed per NH Patient Care Protocols at the EMT-Basic level or higher for patients who have sustained a positive or uncertain mechanism of injury/ nature of injury
3. Determine patient reliability
 - a. Reliable patient
 - (1) Must be over 12 years old, calm, cooperative, sober and alert and oriented to person, place and time
 - (2) If reliable then may continue assessment
 - b. Unreliable patient
 - (1) Altered mental status (dementia, brain injury, psychosis, developmental delay, etc.)
 - (2) Intoxication (alcohol and/or drugs)
 - (3) Acute stress reaction
 - (4) Distracting injury (injury that potentially could distract a patient from the pain of a spine injury)
 - (5) 12 years old and under
 - (6) Communication barrier (deafness, language, etc.)
 - (7) If unreliable, then perform full spinal immobilization
4. Ask patient about spine pain
 - a. Pain present - perform full spinal immobilization
 - b. Pain not present - continue assessment
5. Palpate entire spine for tenderness
 - a. Palpate over each of the spinous processes of the vertebra
 - b. Positive tenderness - perform full spinal immobilization
 - c. Non tender - continue assessment
6. Perform Motor Exam
 - a. Finger abduction and adduction
 - (1) Have patient spread fingers of both hands while you try to squeeze the index finger and ring finger together. Normal resistance should feel like a spring and both sides should have equal strength. (tests the T1 nerve root)
 - b. Finger/wrist flexion and extension
 - (1) Hold patient's arm at the wrist. Have patient try to extend the hands and fingers while you push down against them. The patient should be able to resist moderate pressure and both sides should have equal strength. This may be modified to accommodate an injured wrist or finger by isolating the affected part. (tests the C7 nerve root)
 - c. Foot/great toe flexion and extension
 - (1) Have patient push down with both feet. There should be equal strength on both sides. (tests S1, S2 nerve roots)

- (2) Have patient pull the foot up towards the nose. There should be equal strength on both sides. (tests L5 nerve root)
 - d. Abnormal exam - full spinal immobilization
 - e. Exam within normal limits - continue assessment
 - 7. Perform Neurosensory Exam
 - a. Soft vs. Sharp Touch discrimination in both upper and lower extremities
 - (1) Have the patient close his or her eyes. Touch the patient on the distal portion of an extremity using a dull and then a pointed object. The patient should be able to sense and differentiate a pinprick from a dull sensation. All 4 extremities should be checked and same general area should be tested on both upper extremities and both lower extremities.
 - b. Gross Sensation - abnormal if patient is complaining of paresthasias or radicular pain to one or more extremities. If the patient has a localized injury, that may be taken into consideration.
 - c. Abnormal exam - full spinal immobilization
 - d. Exam within normal limits - continue assessment
 - 8. If part of the exam cannot be completed due to local injury entire exam is unreliable.
 - 9. If patient meets above criteria and can flex, extend and rotate their neck without pain, then spinal immobilization is not necessary.
 - 10. There may exist the rare exception and there are different levels of provider comfort. With that in mind, each provider and team must determine a management plan on a case by case basis, and when in doubt may fully immobilize the patient.
- D. Perform Ongoing Assessment
- E. Communication
 - 1. What:
 - a. Assessment findings (include the results of Advanced Spinal Assessment)
 - b. Treatments
 - c. Results of treatments
 - 2. Who:
 - a. Personnel at receiving facility
 - b. Other EMS providers
- F. Documentation
 - 1. What:
 - a. Assessment findings (include the results of Advanced Spinal Assessment)
 - b. Treatments
 - c. Results of treatments
 - 2. Where:
 - a. PCR
 - b. Performance Improvement / Quality Improvement

- VII. Review of principles of spinal immobilization
1. Primary goal is to prevent further injury
 2. Treat spine as a long bone with a joint at either end (head and pelvis)
 3. 15% of secondary spinal injuries are preventable with proper immobilization
 4. When spinal immobilization is necessary, always use “complete” spine immobilization
 5. Impossible to isolate and splint specific injury site
 6. Spine stabilization begins in the initial assessment
 7. Continues until the spine is completely immobilized on a long backboard or determination is made that immobilization is not necessary.
 8. Head and neck should be placed in a neutral, in-line position unless contraindicated.
 - a. Neutral positioning allows for the most space for the cord
 - b. Most stable position for the spinal column

REFERENCES

McCance, K.L, Huether, S.E., Pathophysiology: The Biological Basis for Disease in Adults and Children (2nd ed.), 1994, St. Louis: Mosby-Yearbook
Thibodeau, G.A., & Patton, K.I., Anatomy and Physiology (2nd ed.), 1993, St. Louis: Mosby-Yearbook
Goth, P., Spine Injury: Clinical Criteria for Assessment and Management (revised May 1995.), Augusta: Medical Care Development.

APPLICATION

Procedural (How)

The instructor will demonstrate the general assessment of patient with a possible spinal cord injury and determine the proper treatment plan using the Advanced Spinal Assessment per NH Patient Care Protocols. The instructor should demonstrate a variety of scenarios that show students examples of each of the treatment plans.

Contextual (When, Where, Why)

For every patient who is involved in any type of traumatic incident in which the mechanism of injury and signs and symptoms indicate a possible spinal injury, complete spinal immobilization must be conducted. Failure to immobilize the spine injured patient will lead to increased patient morbidity and mortality. When patients present with life threats, or the scene is unsafe for the EMT-Basic, the patient is moved by a rapid extrication technique. When a mechanism of injury is uncertain or positive, perform a complete Advanced Spinal Assessment. If the patient presents without any signs or symptoms of a possible spinal injury it may be determined not necessary to immobilize the patient.

STUDENT ACTIVITIES

Auditory (Hear)

1. Simulations in which immobilization techniques are determined not necessary following a complete Advanced Spinal Assessment.
2. Simulations in which immobilization techniques are needed and performed.

Visual (See)

1. The student should see audio-visual aids or materials of the spinal anatomy.
2. The student should see audio-visual aids or materials of mechanism of injury related to potential injuries of the spine.
3. The student should see audio-visual aids or materials of signs and symptoms of a potential spine injury.
4. The student should see a demonstration of the Advanced Spinal Assessment.

Kinesthetic (Do)

1. The student should practice the Advanced Spinal Assessment and determine the appropriate treatment plan.
2. The student should practice completing a prehospital care report for patients with spinal injuries.

INSTRUCTOR ACTIVITIES

Supervise student practice.

Reinforce student progress in cognitive, affective, and psychomotor domains.

Redirect students having difficulty with content.

Evaluation

Written: Develop evaluation instruments, e.g., quizzes, verbal reviews, handouts, to determine if the students have met the cognitive and affective objectives of this lesson.

Practical: Evaluate the actions of the EMT students during role play, practice or other skill stations to determine their compliance with the cognitive and affective objectives and their mastery of the psychomotor objectives of this lesson.

Remediation

Identify students or groups of students who are having difficulty with this subject content and work with student(s) until they have met the cognitive, affective and psychomotor objectives of this lesson.

Enrichment

Identify what is unique in the local area concerning this topic and incorporate into local training modules.